Closeout Report

on the

Director's Review

of

BTeV CD-1

October 21-23, 2003

REPORT OUTLINE

Executive Summary

Major progress continues on the BTeV Project. Design, R&D, and prototyping proceeds on the Detector with the preparation of a Draft Technical Design Report (TDR). The Interaction Region (IR) has been brought into the project and teams in two supporting divisions are being assembled and design on the Conventional Facilities is underway.

From the Technical / Scope point of view, the Detector portion of the project is largely beyond CD-1 and well on the way to CD-2/3 say by Winter; the C0 Conventional Facilities being led by FESS are nearly at CD-1 and can be at CD-2 by Spring; and the IR is coming into place conceptually so that it could be ready for CD-1 early in CY2004 and CD-2 in the Summer.

From the Cost point of view, the Detector costs and Conventional Facilities costs are in good shape for CD-1 approval. The Detector costs with some additional checks for accuracy and consistency by the BTeV Team would be ready for establishing the baseline cost CD-2. The FESS effort and the IR cost baselines could be ready by Spring and Summer respectively. The BTeV Project presented a TEC of $165.68M in FY03$. The committee believes the cost to be in the range of $165M-$178M.

From the Schedule point of view it is desireable to “begin construction” immediately in FY05. Staff assignments from Beams and Technical Divisions are most important for maintaining the design efforts needed to support the possible progress noted in the two prior paragraphs. Additional engineering support and R&D work (beyond that presently planned / funded) on the Detector in FY04 is needed. A construction-installation phasing scenario based on an assumed set of accelerator shutdowns is needed.

Managerially, it seems appropriate to have an experienced project manager with the authority to make decisions and manage the day-to-day project activities who will be devoted full time to the BTeV Project. Unambiguous arrangements to provide this resource should be made by the Fermilab Directorate. Other positions in the Project Office should be filled as soon as possible to support the CD-1 and CD-2/3 preparations (eg permanent schedule and budget personnel).

Finally, with the announcement of P5 strong support for BTeV and if possible an early construction, the Fermilab Directorate is encouraged to work with US and off-shore funding agencies to quickly get funding in place for a timely execution and completion of the project to allow acquisition of data on quark flavor physics as soon as possible.

Summary of the Technical Status of BTeV

The BTeV experiment is a single-arm forward spectrometer in the Tevatron proton-antiproton collider. It emphasizes charged particle tracking and triggering using silicon pixels, silicon microstrip detectors and straw tubes, as well as emphasizing neutral particle reconstruction using a fine-grained lead tungstate (PWO) detector. Particle identification is achieved using both a gas and liquid Ring Imaging Cerenkov (RICH) detector for protons, kaons and pions, and a toroidal spectrometer for muons. The detector triggers on events containing muons or a secondary vertex from *b* quark decays.

The project also includes the beam optics for the low-β insertion and associated civil construction.

The analysis magnet and beampipe tasks are well understood, and R&D on an inexpensive low-mass composite beampipe appears promising. There exists a plan for the activities at C0 (however, based on an schedule made obsolete by the cancellation of Run IIb silicon), including detector infrastructure, but there needs to be more coordination with the subdetector groups. A conceptual design for the interaction region is under development, but would require several new magnet designs: a modified LHC quadrupole and seven different kinds of spool pieces are required.

There are three elements to the tracking detector: pixels, silicon strips and straws. The pixel detector has developed a new cooling plan based on liquid nitrogen (a critical area identified in the last review) and are working on addressing issues with the accelerator: for example, maintaining an acceptable vacuum and responding to beam losses and the steady state radiation profile. Substantial progress has been made in the silicon strip readout chip, also a concern of the 2002 review. A first prototype of this chip is in hand for evaluation. Kapton straws cover the region at larger radius than the strips. Prototypes were built this year and tested with cosmic rays. No evidence of chamber aging was observed. Running with a bunch crossing of 396ns presents difficulties, since the occupancies of the innermost straws may be as large as 40%.

The EM calorimeter is an array of ~10,000 lead tungstate blocks. These blocks have been tested in a beam at Protvino and show a resolution of 1.8%/sqrt(E) and a constant term of 0.33% and indicate that it is likely that the majority of crystals will survive the BTeV environment for at least a decade. Radiation damage to the crystals anneals at room temperature with a time constant of several hundred hours. This makes maintaining a calibration to better than 1% technically challenging. A plan to achieve this has been developed, using electrons from the pixel trigger to establish an overall scale. It takes between 20 minutes and 24 hours to collect enough electrons. Within these periods, calibration stability is monitored and corrected for with red and blue LEDs.

The RICH detector uses two technologies - a mirror-focused gas radiator and a proximity-focused liquid radiator. Specifications for mirror manufacturing tolerance have been generated and some of the installation procedures have been worked out. Two choices for the gas RICH photodetectors have been tested and thus far found to be acceptable: hybrid photodiodes and multianode photomultipliers. The final design choice will be made based on test beam performance and cost at the time of the purchase. The Monte Carlo studies for the gas photo-detector are well advanced. Monte Carlo studies on the liquid radiator are less well advanced, and will be used to investigate whether high detector occupancy will necessitate a switch from using 3 inch photomultipliers to 2 inch photomultipliers.

BTeV's muon detector system is constructed from ~36,000 stainless steel proportional tubes mounted in three planes separated by two 1m thick magnetized iron toroids. The detector design (both mechanical and electronic) is traditional and quite well-advanced. A "vertical lazy susan" design to mount this detector in the constrained space in the BTeV toroid region has been developed. A conceptual design for a flexible trigger system that could be adapted to a wide range of luminosity and background conditions exists. If funding permitted, the muon susbsystem could be ready to begin construction in a few months.

The trigger and data acquisition (DAQ) systems have as a goal to reject 99.95% of the background events and to record at least half of all B events to tape. The primary trigger involves identifying bottom hadrons by their long lifetimes using the pixel detectors, and a secondary trigger identifies them via their semimuonic decays. An unusual aspect is that full events are not written to data storage for offline analysis, but rather DST-like data. The trigger hardware revolves around two farms of processors: digital signal processors and field programmable gate arrays at Level 1, and commodity CPUs at the higher levels. The possibility of use of commodity CPUs at Level 1 is being investigated. One of the few non-off-the-shelf components in the trigger is a large, fast custom switch used in Level 1. Monitoring and fault-tolerance is a major concern, and BTeV plans to use the products of the RTES collaboration. The DAQ has two custom parts: the clock distribution boards and data combiner boards (DCBs), both with a conceptual design, but pre-production parts have not been ordered.

1.1 Vertex, Toroidal Magnet, Beam Pipes (WBS 1.1.)

Findings

- This task includes moving, modifying, and reassembling an existing analysis magnet; building a toroidal magnet for the instrumented side of the IR from existing and new steel and new coils; fabrication of steel shielding from existing and new steel to go in the position of the toroid on the non-instrumented side of the IR; installing existing compensating dipoles into the toroidal magnet and steel shielding; testing and measuring the magnets; installing the magnets in the collision hall; design, fabrication and installation of the experimental beam tube from the window on the end of the pixel detector housing through the RICH.
- The beam tube cost estimate assumes a thin-wall aluminum tube through the Si detector, although R&D on a low-mass composite looks promising.
- The base cost estimate for WBS 1.1 is $1.46M, the contingency estimate is 39%, for a total cost estimate of $2.02M, in FY2003 dollars, with G&A on labor but not M&S. These are essentially unchanged from last year except for 1 year's escalation.
- This year, the cost and schedule information has been loaded into the Open Plan resource loaded schedule.
- The WBS seems to be pretty complete. It is supported by a WBS dictionary, which also contains some basis of estimate information. The entries are generally clear and useful, but many lowest level entries are absent. At least one error was found, in which the description of 1.1.2 implies two complete toroids.
- A Basis of Estimate book was provided. A couple of "drill downs" were performed, with mixed results: some matched the Open Plan data, some hadn't been updated from FY2002 to FY2003 dollars, and some lowest level tasks have no BOE data.
- The order of assembly and installation of the magnets relative to the finishing of the C0 assembly building and the reconfiguration of the C0 straight section has not been settled. (The latter question arises due to the recent deletion of the long shutdown in 2006 for the now-canceled CDF and D0 upgrades.)

Comments

- The cost estimate appears reasonable, at the level that the committee was able to evaluate it.
- The contingency estimates – 34% for the vertex magnet, 37% for the toroids, and 50% for the beam tube, seem quite generous, especially when compared with that for some of the state-of-the-art detector systems, e.g. 41% for the pixels or 30% for the silicon microstrips.
- The milestones do not seem well thought out yet.
- The TDR chapter could be improved by adding more figures and tables giving quantitative information, in preference to some of the text. Fewer details of the procedures to move and rebuild the magnets would suffice, and the step-by-step plan could be moved to a separate referenced document.
- Most of the M&S purchases are likely to be made by Fermilab, allowing the G&A to be accurately estimated
- This subproject appears to be ready for CD-1 review, and with appropriate effort can be ready for CD-2 review by spring or summer.

Recommendations

- Complete and proofread the WBS dictionary and the BOE.
- Project Management should review the contingency estimate to put it on the same basis, relative to the technical and cost risks, as the other L2 tasks.
- Review the milestones to ensure that they correspond to key events, accurately reflect real need dates, and are at the proper density to allow a clear measure of progress.
- Develop a coordinated assembly and installation plan with the IR and civil construction tasks.

1.2 Pixel Detector

Findings

- The pixel group has applied a well organized and systematic program of R&D to this ambitious project and has solved many of the principal technical challenges already. The scope and nature of those challenges that remain is adequately defined, and steps are being taken to meet them in the coming year.

Comments

- Planned beam tests will facilitate decisions that remain to be taken on sensor technology options and will be essential to validate the module design.
- This project needs to receive its funding early in the construction period.
- Approval for construction will allow this project to formalize plans for geographically distributed activities, potentially leading to some cost savings.
- The group plans to continue its study of the outgassing properties of the detector, using the actual materials in the final design.
- The present schedule reflects the funding profile explicitly but manpower limitations only implicitly.
- The documentation that supports the cost estimate is substantial and well organized.
- Significant progress has been made in design of the cooling system.

Recommendations

- Demonstrate the robustness of the proposed design in the case of failure of cooling.
- Continue to work with the Beams Division to understand beam loss scenarios as well as the steady state radiation profile and demonstrate that the detector can survive them.
- Consider increasing contingency on multicomponent systems to reflect uncertainties or risks not present at the single-component stage.
- Ensure that the detector can meet Beams Division vacuum requirements.

1.3 RICH Detector

Findings

- Much technical progress was made in the last year in defining the mirror part of the RICH sub-project, one of the items noted during last year's review. Specifications for mirror manufacturing tolerance have been generated and some of the installation procedures have been worked out.

- The Monte Carlo studies for the main photo-detector are well advanced. Much less has been done for the liquid radiator.

- The costs for the RICH are well developed, with the major items backed up with quotes or estimates from experienced sources. When choices exist (such as using HPD's or MAPMT's for the main photo-detector elements), the more expensive item is costed for the estimate. Adequate contingency has been included on purchases that come from foreign suppliers.

- A prototype RICH test-beam run in spring 2004 will allow a technical choice between the HPD's and MAPMT's. The current funding profile delays the final choice until the order is placed in late FY05. Other purchases (such as the PMT's for the liquid radiator photo-detector and the readout electronics for the HPD's) appear to be driven by the funding profile.

- The schedule as shown has the RICH frame installed in the collision hall after the vertex magnet and toroids have been installed. Internal elements such as the liquid radiator tank and the mirrors are installed on the same time scale. The addition of the "bee-hives" for mounting the photo-detectors comes next. Finally, the photo-detectors are installed in 2009. At the current time, installation of the photo-detector elements is still contained in section 1.3 of the detector schedule.

- There are currently 4 faculty members, 5 post-docs, and several students from Syracuse and a Fermilab mechanical engineer working on the RICH sub-project.

Comments

- More details need to be understood for the liquid radiator photo-detector. Event displays of a very quiet event, as well as a very busy event were available, but typical events were not. It may be that the currently chosen 3-inch phototube size is too large to give adequate separation.

- If the funding profile allows it, it would be advantageous to lock in the choice for the main photo-detector, both from the perspective of fixing the final price and for elimination of the need for multiple design paths for things such as mechanical supports and readout electronics.

- The RICH sub-project is well advanced and certainly ready for CD-1 review. With some embellishments to the schedule and installation plan, they would be ready for a CD-2 review. There are many milestones given in the schedule, at quite a detailed level. Only a few broad upper-level milestones are shown. An intermediate level of reporting would make it easier to track this sub-project.

- The current members of the RICH sub-project have a lot of experience in building this type of detector. Additional manpower, however, would be useful. For example, a new group could assume responsibility for the liquid radiator system.

Recommendations

- Perform additional Monte Carlo studies to examine the phototube size for the liquid radiator photo-detector.

- Develop an intermediate level of milestones.

- Clean up the installation schedule.

1.4 EM Calorimeter

WBS 1.4 covers the PWO crystal electromagnetic calorimeter (ECAL) subsystem. The total base cost is estimated to be 11.3 M$, including 8.9 M$ of material and 2.4 M$ of labor. The overall total cost given by the group is 15.0 M$ including a 33% contingency.

With solid quotes from PMT and crystal vendors, and an updated contingency analysis by the EM group, the reviewer reduced the crystal contingency from 40% to 37.5% and the PMT contingency from 30% to 12.5%.

An analysis of the electronics by the group showed a contingency needed was higher than 30%. The reviewer thus increased the 30% electronics contingency to an estimated 37.5%.

Following the results of the contingency analysis, the reviewer adjusted the contingencies for 1.4.1, 1.4.2 and 1.4.3 accordingly. Base cost was not changed (except –$34K labor double counting with 1.10). The reviewer's estimation is 14.7 M$ overall total cost with 11.4 M$ base plus 29% overall contingency.

Findings

- Mechanical structure for holding the crystals was designed cheaper than CMS and found to be successful.
- PWO crystals from BTCP, Russia, and SIC, China, can be used in the BTeV radiation environment without significant degradation of performance. There are essentially no performance differences between Russian and Chinese crystals.
- Fermilab engineers are working on a new QIE chip and associated ADC cards. Based on history, this should work out well, with prototypes showing up in the spring.
- A prototype LED pulser system was constructed and used in the testbeam. Studies are ongoing to understand how to relate the red and blue LED response to the gain changes of the PMTs and the radiation damage to the crystals from both pions and electrons.
- Calibration of the detector is needed to a fraction of a percent.
- Radiation damage tests of many materials were made: wrapping, glue, quartz plates.
- The team has done excellent work in addressing the 2002 reviewer's comments.
- The team has done excellent work in developing a WBS close to that to be used for CD-2. Tasks are pretty much well defined and details are specified according to personnel and materials
- Reasonable schedules seem to be in place with M&S and labor documented for lowest levels of WBS.

- It is straightforward to review the WBS. At least as much as *this* reviewer has patience with.

- There is considerable backup documentation on big-ticket items for purchase or construction. These make an excellent basis for baseline and contingencies. Other items are costed based on experience and/or prototype costs as in the LED pulser system.

Comments

- There may be electronics R&D costs spilling into FY2005. Fermilab management has stated that no R&D costs should be included in the WBS. This needs to be addressed by the EM group with management.

- After a fresh outlook to the current WBS, it will be straightforward to go to CD-2 level. Some items in the WBS we found had missing costs. The whole document needs to be gone over carefully one more time.

- Crystal procurement from both China and Russia should keep delivery on schedule, even with Russia now committed to CMS. The group would like to do 50-50 each country.

- Maintaining calibration to a fraction of a % is going to be a challenge for the group. Details normally ignored by physicists will need attention. For example, the gain change during collisions due to thermal stresses on the dynodes may have to be considered. The group should make a study to determine at which value the experiment is sort of not worth doing.

- Radiation damage to the forward few % of crystals is an issue. Questions were raised as to the need to replace damaged crystals and the impact on physics that the damaged crystals may have.

- There is detailed documentation in the TDR concerning the plan for calibrating the calorimeter with LED light. Such methods were used in CLEO. There is a concern that cell-cell corrections are not yet well understood, especially if the calibration is needed at 0.1%.

- Electrons will be the primary calibration. There should be a sufficient number from b-decays and minbias. This calibration will be held for 24 hours, and the LED system will monitor in between.

- We suggest that muons should be used for additional calibration points. It will be necessary to lower the threshold of individual cells to obtain these data. It may be a good idea in fact to lower the specification threshold in any case to help distinguish hadron showers and EM showers.

- The group feels reconstructed π°'s not from the vertex will not make a large error. Only the small fraction of minbias events near the vertex will contribute to the background under real π°'s.

- The weakness of the dollar was discussed. It was felt that contracts would be made in dollars. $/yen was thought to not vary greatly, and Russian hard currency is in dollars. So this was not considered in contingency modification.

- The ECAL team does not have sufficient US physicists on the project. All physicists related workloads are currently assigned to the Minnesota University and international collaborators.

Recommendations

- Study the relative crystal-to-crystal response to blue LED light and the correlation to PMT gain and radiation damage of the crystals. Understand better how to apply these corrections to BTeV running conditions.

- Calculate the impact on physics processes due to deterioration of components due to radiation damage.

- Estimate the amount, cost and schedule of new components needed to be replaced if radiation damage deems them unusable.

- Continue to test all detector samples, especially PMTs from various vendors and with different windows, in a BTeV equivalent radiation environment.

- Continue to try to solicit additional US physicists.

1.5 Muon Detector

Findings

Participants include groups from Pavia, Illinois, Vanderbilt and Puerto Rico totaling nine faculty members. The BTeV muon detectors are composed of 1152 "planks" of 32 stainless steel drift tubes. These planks will be assembled into larger units called "octants". Four octants form a “wheel”, two wheels make a “view” and three stations of 4 views each will be installed in the BTeV toroidal magnets. The front-end electronics for each plank uses the Penn ASDQ chip, latches, and a serial link to the DAQ. The chambers operate on a mixture of 85% Argon and 15% CO_2 with an expected maximum occupancy of 2.5%, based on GEANT simulation of pbar-p collisions and MARS simulations of the interaction region.

- The team has done an excellent job with preparing for this review and addressing the comments from the 2002 review.

- A 1/4 scale model of the toroid regions has been constructed for studying installation of the detectors on the toroids and a strategy for mounting them has been developed by Illinois.

- Considerable effort has been expended in minimizing the detector installation time. For example, every detector octant is fully instrumented and tested before delivery to C0. Great care has been taken to minimize the number of service connections.

- A Technical Design Report describing the construction of the muon detector subsystem has been written, and a corresponding resource loaded schedule and WBS using Welcom’s OpenPlan software has been developed. The WBS dictionary is approximately 25% complete. The schedule is paced by funding.

- Most cost estimates were bottom-up estimates based on vendor quotes (and for big-ticket items, multiple vendor quotes). While the Basis of Estimate appears complete, finding a specific item in it can not be done by a non-expert.

- Unburdened base costs have increased by approximately $400,000 since the last review. Labor costs have increased because effort was moved from off-project labor (undergraduate students) to project-funded technicians. Materials costs have increased because of increases in high voltage power supply costs (both per-unit costs and the addition of an adequate number of spares) and addition of test stands. These increases were partially offset by removing items that were needed for the (since descoped) second spectrometer arm.

- Several hundred Level 3 milestones and thirty-eight Level 2 milestones were shown.

Comments

- The detector design is well advanced, straightforward, technically adequate, robust and sound, and the project appears well managed

- In most cases, the materials costs are plausible and the contingency adequate – perhaps even generous. In particular, items with a small risk but large exposure were assigned large contingencies.

- The mounting scheme appears plausible, well documented, and the cost for this element is well understood.

- The number of milestones seems unmanageably large. Higher level milestones on achieving steady state production for major detector components may be at least as valuable as milestones indicating the completion of production.

- The muon subsystem is ready for a DoE review for Critical Decision 1.

- The muon subsystem is not ready for a DoE review for Critical Decisions 2 and 3. The project plan is complete and credible, but not yet well-documented and reviewable. Readiness will require completion of the WBS dictionary, linking WBS tasks to the basis of estimate, and reassessment of the contingency estimate and the milestones. This probably can be achieved in a few months.

- The muon subsystem could be ready to begin construction in a few months, substantially earlier than the present funding profile permits.

Recommendations

- Complete the WBS Dictionary.

- In conjunction with BTeV management, review the contingency estimates

- Participate in a project-wide Installation, Integration and Infrastructure workshop

1.6 Forward Straw Tracker

Findings

- Several standard tests of aging, gain, drift-time (see TDR) have been performed. A test of the elongation of the kapton straws with Ar /CO2 (80%/20%) showed about 16% loss of tension. This is a complication but can be accommodated. No evidence for aging was seen with this gas.

- A simple prototype chamber is set up together with MWPCs for taking cosmic ray data. They will be moved to the test beam when that is available.

- A more complete and refined prototype has been started but needs much more work.

- The unusual carbon fiber gas manifold that joins the ends of the short straws near the beam still hasn't been installed in a prototype and tested.

- R&D was curtailed last year because of low funding stemming from the diversion of funds to other lab activities.

- The lack of dedicated electronics expertise noted last year has been filled by a nearly full time EE plus two or three part time.

- WBS costing is essentially complete but some refinements are still to be done such as adding milestones. Some large electronics items have large contingency (100%). The costing exercise this year resulted in an increase in baseline cost although the per-cent contingency is reduced somewhat (committee estimate).

- Management/coordination of off site production facilities is provided for in the WBS. At each external site a supervisor/Quality Assurance person will maintain the integrity of the facility.

- Running with 396 ns bunch spacing presents some problems to the straw detector. The estimate of the occupancy is high (about 40%) at design luminosity. This means some real hits are shadowed and tracking efficiency goes down in the region near the cutout.

Comments

- Tests on prototype chambers and on mechanical support frames are clearly needed. Some gas studies may be called for but hydrocarbons are not suitable for high rate applications. External sites can become involved in the testing effort as finances will allow. Important to continue the stretch tests inasmuch as using straws under tension is somewhat unusual and relies on straw stability with respect to gas, material and the formulation of the glue. Each manufacturer may use a different glue than another and one specific to each straw material.

- It still looks like more technical help would be beneficial.

- It still looks like more mechanical engineering help would be beneficial.

- Good documentation of requirements and specifications will be needed to maintain quality and uniformity of products constructed at external sites.

- Occupancy in a small part of the area near the beam is clearly too high. Simulation will be needed to evaluate the extent of the problem.

<u>Recommendations</u>

- Continue prototype tests with cosmic rays and in the test beam; involve outside institutions.

- Confirm extent of straw stretching in candidate gas mixtures and with different types of straws; these tests should be long term to discover possible slow creep. Continue developing prototype mechanical supports for the half views.

- Develop the carbon fiber manifold so that it can be used in prototype tests

- Evaluate the loss of tracking efficiency in Monte Carlo for tracks near the cut out region with 396 ns bunch spacing. Coordinate with silicon strips people to find a different matching size, if necessary.

- Continue to refine (scrub) the WBS for better accuracy especially as new information is available.

- In the coming year start to document production and Q/A procedures in preparation for off site production.

1.7 Forward Microstrip Tracker

Findings

- A lot of progress has been shown in particular in the area of the read-out chip. An experienced team has taken the responsibility for design and production of the front-end chip. The chosen approach both for design and fabrication technology is well proven. A first prototype is now in hand for evaluation.

- Several options are still to be evaluated for the chip architecture (shaping time, use of a baseline restorer etc). A realistic plan of submissions and tests has been presented.

- A revised plan for the needed manpower has been presented with a better understanding of the requirements for the major parts of the project.

- The baseline cost seems to be reasonably documented although several important details are still to be finalized and a few minor elements are still missing.

- The technical documentation and the WBS work plan have been updated including the quantities for spares, and prototypes and an appropriate contingency analysis.

- A schedule was presented both for the completion of the R&D and for the construction Phase.

- Progress has been made in the managerial structure but still Level 3 managers are not yet in place.

Comments

- The Schedule for R&D activities has enough contingency while the Schedule for Construction, Commissioning and Integration seems to be compressed and without contingency.

- The rolled up contingency on the whole project is 30%. We believe this is too low for a project at this stage.

- The presented spending profile is unrealistic for FY 2005.

    - The list of milestones for monitoring the progress in the project is satisfactory but milestones for Production Readiness of the Main Components are missing.

    - The Silicon Micro-strip tracker is ready for CD-1. A substantial effort is still needed to be ready for CD-2.

Recommendations

- Costs recommended reflect no change in baseline, but a contingency of 35% is proposed based on lack of finalized designs in some areas, no contingency in the construction schedule and the resultant labor uncertainties.

	Item	Project Estimate ($Millions)				Committee Estimate ($Millions)			
WBS		Base	Cont. %	Cont. $	Total	Base	Cont. %	Cont. $	Total
1.7	Silicon Strip Tracker	6.81	30%	2.05	8.86	$6.99	35%	2.45	$9.43

As a result of this increase in contingency the cost of the sub-detector increases of about 335K$ with respect to the last Temple Review.

- Study carefully the post-irradiation performance of the specially shaped detectors surrounding the beam pipe.

- Implement actions to increase the safety margins in the schedule for the development of the final front-end chip.

- Start as soon as possible the design of the FE hybrid to be able to test the performance of the basic module, after irradiation, with final components.

- Implement experimental tests on quasi-final ladders to qualify the proposed cooling system and all module material and components in terms of thermal properties and mechanical deformations.

- Produce technical designs of the overall mechanical structure including thermal shield and define in detail the interface regions with the beam pipe and the Straw Tracker.

- Produce a set of production readiness milestones for the major components.

- Implement the level 3 management structure.

- Document more fully all cost components of the project including minor details.

1.8 Trigger Electronics and Software

Findings

- The BTeV trigger design is innovative in two principal ways. The proposal is to have a displaced vertex trigger exploiting the properties of the silicon pixel detector at level 1, which imposes a very long level 1 decision time by current standards (hundreds of milliseconds). The second unusual aspect is not to write full raw data to storage for offline analysis, but rather DST-like data.

- BTeV spent significant effort in prototyping elements of the level 1 pixel trigger using existing technologies. The segment finder algorithm has been implemented on prototype hardware and its performance is being verified with simulated (Geant) data. Early results show good consistency with existing software simulations. A prototype of the track and vertex board also exists, and timing studies have been performed on DSP's installed on this board as well as on other embedded processors (PIII and G4). Both prototypes also provide an important guideline in estimating the cost of the corresponding production boards, which represent significant fractions of the total trigger budget.

- On the other hand, the custom level 1 switch used to transfer data from the segment finder board to the track and vertex board has not been prototyped yet, and its description is missing from the current draft TDR. An oral description was given during the breakout sessions, indicating that a fixed routing scheme would be implemented based on bunch crossing. It was mentioned that queuing studies had been done, but documentation was not available at that point.

- It should be noted that the level 1 trigger design is simplified significantly by the split into 8 independent “highways”, with data sent to a specific highway based on bunch crossing (see WBS 1.9).

- There is a level 1 muon trigger, who's main purpose is as a monitor trigger for the displaced vertex trigger. BTeV plans to use hardware which is very similar to the level 1 pixel trigger to implement this as well as the global level 1 trigger. The latter will issue the level 1 decision based a trigger list and the results from the pixel and muon triggers.

- Data size estimates based on Geant simulation of the detector are used to determine the bandwidth requirements for each of the data transfer elements.

- Level 2 and 3 are run on a farm of commodity computers, with both levels run on the same node for a specific event. Level 2 uses only pixel information, while level 3 runs the offline reconstruction software.

- The monitoring of the large number of real-time or quasi-real-time processors in the BTeV trigger is an issue which has been raised by previous reviews. BTeV plans to use, but not depend on tools developed by the RTES collaboration.

- Based on "OpenPlan" (the project management software used), there are 3 items on the critical path:
    - o the procurement of the level 2/3 farm,
    - o muon trigger hardware, and
    - o monitor software.

- The first is by design (commodity computers are consciously procured at the last possible moment), the second is correlated with the development of the level 1 pixel trigger hardware, and the third is often underestimated in HEP experiments.

Comments

- The fact that BTeV now has working "pre-prototypes" of the level 1 pixel segment finder and track and vertex boards in hand is very encouraging. Furthermore, the timing studies performed on pentium and G4 processors lead to believe these processors may provide the best option for the final implementation of the track and vertex boards, both due to cost and ease of use. Of the level 1 pixel trigger hardware components, only the switch has not been documented or prototyped. The scheme explained at the breakout session keeps this as simple as possible by implementing a round-robin-like scheme for routing based on bunch crossing, but this implies that the farm of track and vertex boards needs to have sufficient overcapacity to limit datalosses due to routing of events to boards with full buffers. The only active load balancing at this stage is done on the boards themselves, where a buffer manager can choose any of 6 processors to process the event.

- The hardware for the level 2 and 3 triggers is composed of commodity computers and networking equipment, and does not pose any technical risk. However, the development of the level 3 filtering software is severely understaffed, and BTeV is counting on joining institutions to contribute significantly to this effort. This issue is even more critical than in previous experiments, since BTeV sees level 3 as its offline platform. Conversion from raw data to DST happens at this stage.

- A fair fraction of the cost estimate is based on pre-prototypes (L1) or experience in other experiments (L2/3) and can be considered reliable. Cost for elements for which no prototypes exist have been evaluated based on preliminary designs which appear sound. The development of the level 2/3 farm management software, as well as labor costs associated with procurement and installation were assigned a 100% contingency, but at this point these are well-understood problems and this should be reduced to 35%.

Recommendations

- Describe the level 1 switch in the TDR asap.

- Develop a prototype level 1 switch and the test setup required to simulate realistic conditions.

- Continue the pursuit of alternate processor solutions for the track and vertex processors, and build corresponding prototype daughtercards.

- Evaluate RTES tools promptly with prototype hardware (at all levels).

- (Strongly) encourage new institutions to contribute to the level 3 filtering software development.

- Develop a preliminary staged plan for reduction of data size to permanent storage from the full raw data to DST. Estimate the gains/drawbacks at each step and their impact on physics analysis.

1.9 Data Acquisition and Controls

Findings

- The data acquisition part of the experiment provides the Data Combiner Boards (DCB) that combine data from various front-ends before sending it on to level 1 buffers and the level 1 trigger if applicable. The level 1 buffers in their turn store the data until a trigger decision has been made, which can be hundreds of milliseconds. Once the trigger decision is received, the data is either sent to a level 2/3 node, or the corresponding memory is returned for use by another event. At this point none of these two components have been prototyped.

- The other custom hardware component part of WBS 1.9 is the clock distribution system, for which multiple options are still being considered.

- The data acquisition group is also responsible for slow control, databases, run management, event building and temporary data logging before transfer to FCC.

- One of the major simplifying steps taken is to split the data at the DCB output into 8 data “highways” based on the bunch crossing. This reduces the datavolume in each highway by a factor of 8, but mostly reduces interconnections between different components drastically (typically by a factor of 64).

- The cost drivers for this part of the project are dominated by labor, mainly engineering and control and monitoring software.

Comments

- While the level 1 buffers are expected to be very simple components, the DCBs do not only receive the data from multiple front-ends and combine it before sending to the level 1 buffers, but are also supposed to transfer control information to the front-ends. In this light, it would be desirable to have operational DCB prototypes at a fairly early stage so that interactions with the various front-ends can be debugged, and front-end developers can get used to programming their boards in a standard way. Furthermore, there is an issue as to the DCB location and levels of radiation which has the potential to drag on for a long time, since no measurements of the radiations levels can be made until the BTeV optics are in place.

- BTeV proposes to route events to one of their 8 trigger highways based on bunch crossing, which simplifies their design significantly. But this implies there is no intelligent load balancing between highways, and the chosen scheme should be optimized to reduce significant imbalance due to accelerator bunch loading etc.

- The clock distribution scheme is as yet not finalized, and while none of the BTeV detectors require very precise timing, it is important to find out if some of the components' performance could be negatively affected by clock jitter (some optical transmitters/receivers for example are known to be sensitive to this). It should be noted that in the current design the DCBs distribute the clock signals to the front-ends, so that tests with DCB prototypes could be used to improve the clock distribution design.

- The main critical path item in WBS 1.9 is the DCB development and production.

- The cost estimates appear to be sound.

Recommendations

- Develop a DCB prototype.

- Choose a clock distribution scheme and prototype the corresponding hardware. Investigate interactions with the various trigger and DAQ components.

- Evaluate the radiation levels in the proposed DCB locations and their impact on DCB performance. Determine DCB location and verify adequate performance of the cables to the front-ends.

1.10 Installation and Integration

Findings

- The WBS as presented totaled 5.4 M$ base cost with an estimated contingency of 29% for a total estimate of 7.0M$. Of this, 80% is labor and 20% M+S. This project has its labor contingency at 30% and its M&S contingency at 20%. The total project cost has increased 20% since the last "Temple" review in Oct 2002.

- The installation estimates for each detector component's (L2 task) installation was developed by the other L2 managers and transferred to this WBS. Contingency on these tasks was done jointly with the other L2 managers.

- The WBS includes receipt of subassemblies from the other L2 tasks and provides for final installation of each detector into the C0 collision hall. With the exception of the magnets, each detector is assembled elsewhere and tested prior to being shipped to the C0 hall. Shipment costs are included in this WBS.

- The project documentation is quite far along. The WBS for this task contains in excess of 600 separate activities. A first pass of the WBS dictionary as well as a preliminary cost analysis is complete.

- A random drill down on the WBS item showed that the cost and schedule is reasonably complete but that there is still work to be done. We were 50% successful. The basis of estimate book is incomplete.

- Milestones do exist for this project. There are currently 45 level 1,2, and 3 milestones. Many of these milestones have the same date.

- The installation schedule is out of date. It assumes a long lab shutdown in 2006 that no longer exists.

Comments

- A tremendous amount of work has gone in to the preparation of the documents and schedules under review. It is impressive what this group has been accomplished with limited time and resources.

- The boundary between Installation and Integration and each of the detector groups is not well defined. The reviewer feels that its current definition is too narrow. This reviewer would minimally include in 1.10 all permanent installation activities at C0. For example, cooling, gas mixing and delivery should be moved to this project in order to maintain control and schedule.

- While common items such as relay racks are specified as part of this task, the costs are distributed though out the rest of the project. This makes it very difficult to know whether all of the infrastructure items is properly costed. Similarly, the resources for installing them are spread throughout the detector groups.

- The WBS ,as currently written, “feels” like it was cut and pasted together. With its current organization, it is not as useful to the project managers as it could be to actually manage the project. Furthermore, it needs to be “scrubbed” to ensure all the tasks in the individual sub project installation narratives is included in the schedule.

- Too many common item tasks are being pushed on the detector groups. For instance 1.10.4.7.1.3.1 (installation of slow control crates in racks). Every rack needs one and yet as written, this task is performed by grad students. This will lead to a lack of uniformity across rack systems that will make maintenance and trouble shooting more difficult further down the road.

- Given the limited access time to the C0 collision hall, its readiness may be on the critical path.

- The reviewer feels that the labor cost with contingency is too low. It is felt that too many of the task durations will require everything to go perfectly well in order to stay on schedule. The reviewer would double the labor for contingency bringing the overall labor contingency to 60%. The total cost would then increase from 7.0M$ to 8.5M$.

- The interaction between the activities in this project with the construction of the IR and civil construction of C0 is not well thought through. It is unclear who sets the priorities?

- No formal configuration control system was presented. Such a system will be crucial to insure that installation goes smoothly given the severe constraints of the C0 collision hall and access to it, and to ensure that the experiment acts as an integrated unit. This is not necessary for CD-1 but it is for CD-2.

- With some work, this sub project can be ready for CD-1 in the next few months.

- The reviewer feels that there are currently insufficient design resources in the current plan. Although BTeV is, in many ways, set up like a "fixed target" experiment, there are still a number of potential interferences that need to be thought through and properly engineered. Furthermore, given that there will most likely be less shutdown time available for early detector installation, these design resources may be well spent looking at how to expedite the roll in each of the detector subsystems.

Recommendations

- Schedule a workshop with the I&I team and each of the other L2 managers to discuss how each group interfaces with this team and make sure the overall goal of a complete experiment is accounted for in one of the schedules. Have a formal sign-off with each L2 manager.

- Pick a reasonable lab shutdown schedule (say 6 weeks down every July/august) and go through the exercise of developing a full resource loaded schedule for the construction of the experiment. Look for conflicts in each subsystem as well as global resource demands.

- Scrub the WBS plan – look for holes and inconsistencies. Rework the WBS so that it is in a form that is useful for the L2 managers to manage the project with.

- Complete the cost estimates and BOE required in order to achieve CD2.

- Establish with the project office how conflicts in tasks 1.1, 1.10, 2, and 3 as they require space in the collision hall and assembly hall are resolved and how priorities are set.

- Establish a set of sensible milestones that can track the progress of this project.

- Establish a rigorous configuration control system, controlled by the Project Office, in draft form before the DOE CD-1 review

- WBS 1.10 was originally created for installation of the detector, now that there is installation work associated with the IR and critical links to the Conventional Construction activities the project should consider elevating the Installation activities to a Level 2 in the WBS. For the same reason the Project Management section (WBS 1.11) is going to be moved to Level 2, the Installation should be moved because it would cover installation activities for the entire project.

1.11 Cost and Schedule

WBS	Items	Project Estimate (K$)				Committee Estimate FY03 (K$)				Note
		Base	Cont. %	Cont. $	Total	Labor and M&S w/Indirects	Cont. %	Cont. $	Total	
1.1	Vertex, Toroidal Magnet, Beam Pipe	$1,455	39%	$567	$2,021	$1,602	30%	$481	$2,083	(1)
1.2	Pixel Detector	$13,611	41%	$5,576	$19,187	$14,531	41%	$6,017	$20,548	
1.3	RICH Detector	$11,641	28%	$3,244	$14,885	$12,128	28%	$3,368	$15,496	
1.4	EM Calorimeter	$11,307	33%	$3,735	$15,042	$11,397	29%	$3,300	$14,697	(2)
1.5	Muon Detector	$4,198	38%	$1,580	$5,778	$4,251	31%	$1,308	$5,559	(3)
1.6	Forward Straw Tracker	$6,971	36%	$2,515	$9,486	$7,445	36%	$2,688	$10,133	
1.7	Forward Silicon Microstrip Tracker	$6,815	30%	$2,054	$8,869	$6,989	35%	$2,446	$9,435	(4)
1.8	Trigger Electronics and Software	$11,140	44%	$4,871	$16,011	$11,514	42%	$4,798	$16,313	(5)
1.9	Event Readout and Controls	$11,417	32%	$3,615	$15,032	$11,802	32%	$3,777	$15,579	
1.10	System Installation, Integration, etc	$5,442	29%	$1,568	$7,010	$5,601	51%	$2,877	$8,478	(6)
1.11	Project Management	$8,355	25%	$2,075	$10,430	$8,451	25%	$2,095	$10,546	
2.0	Interaction Region	$25,414	33%	$8,386	$33,800	$29,950	40%	$11,980	$41,930	(7)
3.0	Conventional Construction	$5,583	19%	$1,051	$6,634	$5,618	19%	$1,068	$6,686	
	M&S Indirects for Detector	$2,500			$2,500					
	Total	$125,849	32%	$40,837	$166,685	$131,279	35%	$46,202	$177,481	

Notes:

GENERAL:

- The indirects for the M&S cost in the BTeV project estimate was not calculated and included in each WBS line for 1.1 through 1.10, but a lump sum estimate of $2.5M was added at the bottom. The Committees estimate calculated and included the M&S indirects for each line of the WBS.
- Fermilab's M&S Indirect Pass-Through Rate of 1.5% was applied to purchase orders going to Universities.
- Currently there is 3 Fermilab Procurements projected to be over the $500K. The allowed approximately $2.3M to be exempt from M&S Indirects.
- Labor Contingency % was applied against the FNAL labor and the University Labor (M&S Costs) and the Material Contingency % was applied against the Fermi and University material purchases.

SPECIFIC:

1. WBS 1.1 – The estimates should be put on the same basis relative to the technical and cost risks, as the other L2 tasks. The contingency estimates – 34% for the vertex magnet, 37% for the toroids, and 50% for the beam tube, seem quite generous, especially when compared with that for some of the state-of-the-art detector systems, e.g. 41% for the pixels or 30% for the silicon microstrips.
2. WBS 1.4 – With solid quotes from PMT and crystal vendors, and an updated contingency analysis by the EM group, the reviewer reduced the crystal contingency from 40% to 37.5% and the PMT contingency from 30% to 12.5%. An analysis of the electronics by the group showed a contingency needed was higher than 30%. The reviewer thus increased the 30% electronics contingency to an estimated 37.5%. Contingencies adjusted for 1.4.1, 1.4.2 and 1.4.3 accordingly. Base cost was not changed (except –$34K labor double counting with 1.10).

3. WBS 1.5 - Materials costs are plausible. Contingency is perhaps generous; in particular, items with a small risk but large exposure were assigned large contingencies.
4. WBS 1.7 – Costs recommended reflect no change in baseline, but a contingency of 35% is proposed based on lack of finalized designs in some areas, no contingency in the construction schedule and the resultant labor uncertainties.
5. WBS 1.8 – The development of the level 2/3 farm management software, as well as labor costs associated with procurement and installation were assigned a 100% contingency, but at this point these are well-understood problems and this should be reduced to 35%.
6. WBS 1.10 – It is felt that the labor cost with contingency is too low and that too many of the task durations will require everything to go perfectly well in order to stay on schedule. The labor for contingency was basically doubled bringing the overall labor contingency to 60%.
7. WBS 2.0 – Base costs increased based on recent work has shown that the number of new spool types is larger than previously believed (7 vs. 3), and it has been realized that a spare of each type must be built. Contingency was also increased to 40%.

Findings

- The schedules for the Detector exists in Open Plan, but schedules still have to be developed in Open Plan for the IR and the Conventional Construction.
- R&D activities exist in Open Plan and there are link to Construction activities where required. At this time the R&D activities are not being statused.
- Master Schedule linkages between Detector subprojects have not been completed at this time.

Comments

- BTeV should continue to on identifying and input the linkages between the subprojects in Open Plan so an over Project critical path can be analyzed and adjustments made.

Recommendations

- BTeV needs to review and scrub their milestones. Make sure milestones add value and identify key activities that are useful to manage the project and demonstrate progress.
- BTeV needs information on future shutdown schedules and durations
- The schedules for the IR and Conventional Construction subprojects need to be completed and integrated into the overall Master Project Schedule as soon as possible in order to better analyze overall integration.

1.12 Project Management (WBS 1.11)

Findings

- BTeV has created a list of activities for and a plan for staffing the Project Office.
- The cost estimate based on this plan is $10.5M over the life of the project.
    - The sum of additional management costs contained in the Level 2 budgets is another ~$5M.
- The BTeV Collaboration Spokespersons have been and are acting as Co-Project Managers.
- A detailed work breakdown structure (WBS) has been put in place for the Detector.
- The Detector schedule is created in Open Plan and is keyed off the WBS.
- A WBS Dictionary and (/or) basis of estimate (Basis of Estimate) is created in Open Plan for each Detector sub-project.
- The schedule has been resource loaded (RLS) in Open Plan.
    - The separate RLS have been concatenated by PO staff into a global schedule. Links between the sub-projects have not yet been incorporated.
    - This effort has been significant and there is some resistance to implementing and using Open Plan by some Level 2 managers, but the BTeV Project Office continues to provide encouragement for the use of this tool.
- A Detector Conceptual Design Report, based on information presented in the proposal has been prepared.
- A Conceptual Design Report for the work to be managed by the Fermilab Facilities Engineering Services Section has been prepared.
- Initial layouts for the Interaction Region (IR) have been developed.
- A draft Detector Technical Design Report has been prepared.
- Preparation of formally required DOE project documentation has gotten underway, including:
    - A CD-0 Decision Document,
    - A Justification for Mission Need (JMN),
    - An Acquisition Execution Plan (AEP), and
    - Project Execution Plan (PEP); all of which have begun or are beginning iterations with and within the department.

- Work on a Project Management Plan and Project Information Form (PIF) to support a NEPA status of a Categorical Exclusion has begun.

Comments

- The "total" management cost of ~$15.5 on a roughly $165M project are close to a 10% rule of thumb sometimes used on large complex projects.

- As BTeV becomes a project, the load on the project office and the Project Manager(s) will increase greatly. There is concern about whether the dual roles of Co-Spokespersons and Co-Project Managers will allow time to fully meet the requirements of the Project Manager position. Furthermore, there are thought to be possible "built-in" conflicts of interest between the two positions.

- Although the Detector schedule is quite well developed, the recent incorporation of the IR and conventional facility efforts into the project means they do not yet have well developed schedules.

- Furthermore, there is not a (one or more) strategic scenario(s) for the sequence of performance of various building outfitting tasks and detector installation of large components vis a vis accelerator shutdowns (even an assumed "strawman" set of shutdowns).

- A project-wide workshop in Integration and Installation of all efforts might be useful in developing and integrated construction-installation scenario.

- The milestones presented were frequently "bunched" at the end of the project.

- The Draft Detector TDR is a good start and a few constructive comments are made in the technical sections of this report. Since the TDR was so far along, the CDR for the Detector was not reviewed in any detail.

- The Project Engineer for Mechanical Engineering is particularly heavily loaded. Additional engineering support would help alleviate this condition.

- The WBS Dictionary and BOE entries were mixed; BTeV may want to make these more uniform.

- The CDR for the Conventional Facilities is limited in the electrical area due to lack of EEs in FESS. This work is to be done by a support contractor.

- Reviewmanship:
    - In addition to knowing what you're doing, you MUST APPEAR to know what you're doing.

    - Materials (including plenary presentations) 1-2 weeks ahead of time.

- All presentations on one single computer to save time and avoid broken connector problems.
- Dry run overhead projection / computer hook-up.
- Tabbed notebooks of presentation material.
- Description and distribution of back-up materials.
- WBS Dictionary hardcopies.
- Say ~two examples of how WBS Dictionary, BOE, schedule, and RLS created with detailed BOE support. Then personnel in each breakout session who can "drive" the Open Plan tool to answer random questions from reviewers on scope, cost, and schedule in the TDR and Open Plan.
- Hardcopies (and / or e-posted versions) of materials presented in the breakout sessions.

Recommendations

- Work with Fermilab Directorate to provide needed support at the Project Manager level. If the dual roles persist, the appointment of a (Principal) Deputy Project Manager with experience in project management, who is authorized to make decisions, and is dedicated full-time to the project might fill the need.

- Provide resources in Beams Division (BD) and Technical Division (TD) to support the IR Conceptual Design for CD-1 and the Preliminary Design for CD-2. Provide funding for FESS staff and subcontract work necessary to complete the CDR for CD-1 and conduct advanced conceptual design for CD-2.

- Acquire additional staff in the Project Office needed to develop documentation in support of DOE Critical Decisions 0, 1, and 2. This would include a budget officer and permanent scheduler.

- Develop a project phasing scenario for completion of the conventional facilities and installation of detector components.

- An additional focussed Director's CD-1 Review on the IR, Conventional Facilities, and construction / installation phasing should be conducted prior to a DOE Lehman CD-1 Review.

- Complete the formally required DOE project management documentation to support CD-0 immediately, CD-1 in the next few months and CD-2/3 in the coming six months.

- Establish 2 or 3 important Milestones per year for each Level 2 system as PM milestones. A subset of these milestones can then be used in the formal project documentation such as the PEP and supersets can be used by Level 2 and 3 managers to manage their systems.

1.13 Interaction Region (WBS 2.0.)

The IR has only recently been added to the BTeV Project, and its technical design and cost and schedule estimates are considerably less well developed than those of the detector systems. It does not have actual L1 or L2 managers, with those acting as them serving on a "fill-in" basis. This system does not yet have a complete conceptual design, and, as a consequence, it does not have a complete cost estimate, nor is there yet a fully defined work breakdown structure. The IR is not currently ready for a CD-1 review, a fact with which the acting managers agree. Specific findings, comments and recommendations follow.

Findings

- An optical design exists, which passed a review in February 2001. Little additional optics or beam dynamics work has been done since then.

- Dynamic aperture tracking studies needed to verify that use of LHC quads is ok haven't been done yet.

- Studies of BTeV's impact on the accelerator, and studies of risks to the close-in pixels from beam upset conditions haven't been done yet.

- It has been verified that the optics design is plausibly consistent with engineering constraints on cryogenics, magnet strengths, etc., but no significant engineering studies have been done for much of the required new equipment.

- Conceptual designs exist, but haven't yet been documented for the "main" quads (Q1-Q5). This could form the basis for developing a WBS and cost and schedule estimate, but detailed work on this is yet to be done.

- No conceptual designs exist for the 7 types of new spools required, the various new corrector types, nor the tooling and test equipment needed to assemble the magnets, correctors and spools. Cost and schedule estimates have been made by crude top-down scaling from similar recent jobs.

- Orders need to be placed this fiscal year for some long-lead items, such as initial quantities of superconductor and steel, or by the middle of next year for other items, such as the balance of the superconductor and steel and 10kA HTS power leads, and a magnet test stand feedbox. Sufficient up-front engineering must be done this fiscal year to support these orders.

- Recent work has shown that the number of new spool types is larger than previously believed (7 vs. 3), and it has been realized that a spare of each type must be built. These additional costs are not included in the cost estimate summary shown at the review.

- It is believed that there may be some double counting of costs between some elements in the IR estimate, and between the IR and C0 outfitting task (WBS 3.0). However, these are expected to be small compared with the additional costs of building more spools.

Recommendations

- Laboratory and BTeV management need to assign L1 and L2 managers for the IR as soon as possible. Especially for the L1 and the L2 magnet system managers, this should be their major job assignment.

- Laboratory management needs to provide the needed manpower, estimated to be of the order of 6 FTEs in TD and 3 FTEs in BD to develop the conceptual design, WBS, and baseline cost and schedule ranges for the DOE CD-1 review anticipated for February. In addition, 3-4 more FTEs in TD will be required to establish the technical, cost and schedule baselines for the CD-2/3 review anticipated for late spring or summer 2004, and to do the necessary design work to allow long lead-time procurements to be placed in FY2004 and early FY2005, as required to support a 2009 start for BTeV running. The necessary personnel need to be assigned ASAP.

- Schedule a follow-up Director's CD-1 review for the IR and other accelerator activities in the next 6-12 weeks. It should be late enough to allow serious work to be accomplished, while being far enough in advance of the DOE CD-1review to allow feedback from the Director's review to be acted upon.

1.14 Building Outfitting (WBS 3.0.)

Conventional Construction

<u>Findings</u>

Civil Construction for the BTeV project forms WBS 3.0. This recent organization has a level 1 manager from Fermilab FESS (T. Lackowski). Staffing of lower level managers is ongoing.

- The current WBS structure goes to level 4 and contains the large work categories only (Engineering, Construction, etc.).

- The civil construction includes work in the existing C0 building shell, such as adding 2 floors, and final building infrastructure systems. Detector power (e.g. for the analysis dipole magnet) will be brought from the B4 Service Building via a berm penetration. The other major civil construction item is the refurbishment of the C0 service building to support power supplies for the C0 low-beta insertion. This item includes installation of two transformers at C1 and B4 Service Buildings.

- A Conceptual Design Report has been produced which contains a preliminary set of layout drawings for architectural and mechanical subsystems.

  - A cost estimate using input from the project and standard construction cost estimation techniques has been developed, building on earlier design studies. Some vendor quotations have been included in the cost estimate, and work in this area is continuing to refine the estimate. Total estimated cost for this WBS is $6.64 Million, which includes approximately 20% contingency.

  - There is not yet a bottom-up schedule for the civil work, which must be tightly integrated with the accelerator and experiment installation schedules. The overall duration of the construction work is estimated to be about one year with 6 months of restricted access to the BTeV Assembly Hall.

<u>Comments</u>

- The civil construction for BTeV outfitting is standard construction with only one or two, relatively simple, distinguishing features such as the incorporation of precast concrete floors to an existing building shell. The work should present little technical risk.

- Some schedule risk may occur depending on the sequence of project needs. Early, complete, Title II work will allow the most flexibility for structuring civil contracts.

- Contingency and EDIA estimates are adequate for this stage of the project.

- Lack of in-house electrical design capability has slowed work on conceptual design drawings and will cause burdens on the senior project staff.

Recommendations

- Develop a schedule including a model of laboratory shutdowns to refine the scope and sequence of Civil Outfitting contracts, and to identify any places where the Civil Outfitting impacts the project critical path.

- Define a formal approval procedure to ensure that all physics subsystem requirements, including schedule requirements, are transmitted to the Civil Construction managers and approved by all other relevant system managers.

- Produce a complete drawing set of the conceptual design including electrical and process piping required for the collision hall and assembly hall.

1.15 Action Items

1 BeTev is to respond to the Recommendations documented in this report by the end of December 2003. BTeV is to present their response during the first BTeV Working Group Meeting in January 2004.

2 A follow-up Director's CD-1 Review is to be conducted on the IR and other accelerator activities prior to the DOE's CD-1 Review. The target date to conduct this review is during the wek of January 26, 2003.

3 A Director's CD-2/3a Review is to be conducted in the spring of 2004.

Appendix 1
Review Committee Charge

BTeV CD-1 Director's Review
Wednesday, October 22, 2003

Draft Charge

This charge is for the Committee to conduct a Director's Critical Decision – 1 (CD-1) Review of the proposed BTeV project at Fermilab. Approval of CD-1 will allow the expenditure of funds for design to proceed from the Conceptual Design phase to the more detailed design phase.

Approval of CD-1 by DOE officials is based on a ***Conceptual Design*** for the project, a ***cost and schedule baseline range***, and some additional project management documents. ***The cost and schedule ranges are usually based on a detailed WBS – Work Breakdown Structure, WBS Dictionary, BOE – Basis of Estimate documentation, risk and contingency analyses, RLS – Resource Loaded Schedule, and time phased funding and cost profiles. The committee is asked to review each of these items, for quality, completeness, and accuracy***. Furthermore, the committee is asked to ***review and assess the quality of and comment on the additional formal project management documentation required for CD-1 approval***. *Also, please evaluate BTeV responses to recommendations from the 2002 Status Review.*

A Lehman Review corresponding to a DOE CD-1 Review is being requested soon after this Director's Review. Therefore, a key purpose of this review is to ***assess the readiness of the BTeV Project for a Lehman CD-1 Review***. Constructive comments on presentation content, format, and style are requested.

The P5 (Particle Physics Project Prioritization Panel) evaluation and recommendation regarding BTeV as set forth in their recently releases report reads as follows: "The P5 supports the construction of BTeV as an important project in the world-wide quark flavor physics area. Subject to constraints within HEP budget, we strongly recommend an earlier BTeV construction profile and enhanced C0 optics."

Fermilab and BTeV are planning for CD-3 approval, begin construction, at the beginning of FY2005 (October 1, 2004). To achieve this goal BTeV will need a Lehman CD-2/3 Review in the summer of 2004. The BTeV Collaboration has made good progress in the preparation of a Technical Design Report for the Detector. Therefore, the committee is asked to *comment as appropriate on BTeV's status regarding readiness to "establish a baseline budget*." Again, appropriate constructive comments on what remains to done are requested.

Finally, the committee should present findings, comments, and conclusions at a closeout meeting with BTeV and Fermilab management and provide a written report soon after the review.

Appendix 2
Review Committee Membership

Gustaaf Brooijmans
Dean Hoffer
Don Holmgren
Tom LeCompte
Rob Plunkett
Rob Roser
David Rust
Sally Seidel
Bob Stanek
Jim Strait
Linda Stutte
Ed Temple, Chair
Guido Tonelli

Observers
Claudio Luci
Paul Philp

Directorate
Jeff Appel
Hugh Montgomery
Ken Stanfield

Appendix 3
Review Agenda

Director's CD-1 Review
of
BTeV October 21-23
REVIEW AGENDA

Tuesday, October 21, 2003	**1 West**
8:00 AM – 8:45 AM	Executive Session
9:00 AM – 9:15 AM	Introduction
9:15 AM – 10:15 AM	Project Overview
10:15 AM – 10:30 AM	BREAK
10:30 AM – 11:30 AM	Tracking Systems
11:30 AM – 12:30 PM	LUNCH on 2nd Floor Crossover
12:30 PM – 2:00 PM	Particle Identification Systems
2:00 PM – 2:45 PM	Mechanical and Integration
2:45 PM – 3:00 PM	BREAK
3:00 PM – 4:00 PM	Trigger & DAQ
4:00 PM – 4:45 PM	Interaction Region
4:45 PM – 5:30 PM	C0 Building Outfitting
5:30 PM – 6:30 PM	Executive Session (Held in Comitium)
6:30 PM – 7:00 PM	Coctail Hour
7:00 PM	Dinner at Chez Leon

Wednesday, October 22, 2003	
8:00 AM – 12:00 Noon	Technical/Cost/Schedule Breakout Sessions (See Breakout Chart)
12:00 Noon – 1:00 PM	LUNCH
1:00 PM – 2:30 PM	Continue Breakout Sessions
2:30 PM – 3:00 PM	BREAK
3:00 PM – 4:30 PM	Executive Session (Held in Comitium)
4:30 PM – 6:00 PM	Begin Writing Report

Thursday, October 23, 2003	
8:00 AM – 11:00 AM	Continue Writing Report
11:00 AM – 1:00 PM	Dry Run of Closeout (Held in Comitium)
(11:45 AM – 12:30 PM)	Grab Working LUNCH (continue Dry Run of Closeout)
1:00 PM – 2:00 PM	Finish Writing Report
2:00 PM – 3:00 PM	Upload Report Sections
3:00 PM – 4:00 PM	Closeout w/ BTeV and Fermilab Management (1 North)